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理學院博士生歐茲比 龍友翰 發表石墨烯論文

【記者高瑞妤淡水校園報導】本校物理系主任莊程豪指導理學院應用科學博一生歐茲比和博二龍友翰，於5月6日被《Journal of Electron Spectroscopy and Related Phenomena》期刊接受，發表「Scanning transmission X-ray microscopy of hydrogen evolution electrocatalysts on reduction graphene oxide membranes」論文。莊程豪表示，影響因子1.993雖不高，但是屬於同步輻射領域中的老牌期刊。

莊程豪表示，歐茲比為第一作者，此篇與美日學者共同跨國合作，於本校實驗室中完成。論文說明當使用氧化石墨烯薄膜的基板，可以提升金屬鈷的水析氫催化效果，藉由原位電化學質譜儀，觀察到較高氫氣產生量和較高反應負電壓，若基板換成還原氧化石墨烯薄膜時，其析氫效果可再度提升。此研究提供重要基板調整電鍍鈷的氧化狀態，並能應用到奈米能源材料的分析成果中。

歐茲比為去年有蓮獎學金得主，他表示：「在短短一年中，受到學校的栽培和莊程豪老師的訓練，能快速找出鈷相關能源材料，經由先進同步輻射Ｘ光顯微術做出成果，順利發表於同步輻射專業期刊，除了自身的努力外，非常感謝學校和老師的幫忙。」


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Scanning transmission X-ray microscopy of hydrogen evolution electrocatalysts on reduction graphene oxide membranes

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ABSTRACT

Cobalt is one of the promising metal catalysts for hydrogen evolution reaction, and its catalytic performance can be further improved by supporting on graphene oxide and reduced graphene oxide as an active interface to the substrate. Scanning transmission X-ray microscopy (STXM) identifies the position-dependent functional groups on the membranes and chemical structure evolution of the Co_xO_y. The in-situ mass spectrometer analysis shows the reduction current and H_2 generation of the electrocatalyst enhanced by the addition of graphene oxide and reduced graphene oxide to Co_xO_y, as compared to the Co_xO_y on the bare substrate. The best hydrogen evolution reaction performance of Co_xO_y at − 2.5 V is correlated with the high Co^{3+} concentration existed on the reduced graphene oxide, as evidenced by the nano- and element-resolved capability of STXM. With the economical electro-reduction synthesis, this study provides brand-new insights into the critical role of substrate rGO and electrocatalyst Co_xO_y toward the design of high efficiency electrocatalyst.

1. Introduction

In the past years, cobalt has gained attention for its performance as an electrocatalyst for hydrogen evolution reaction (HER) [1,2]. HER is an essential step in many renewable energy technologies, mainly water splitting, which produces hydrogen as a clean and sustainable energy carrier. Cobalt-based catalysts have shown promise as efficient and cost-effective alternatives to traditional platinum-based catalysts, which are expensive and scarce. These catalysts have high activity and stability, making it a good candidate for the HER [3,4]. Many cobalt compounds have been studied recently, such as cobalt sulfides, phosphides, borides, and selenides [5–9]. The combination of cobalt and graphene (G) -based materials has been found to have a synergistic effect in improving the activity and stability of the oxygen evolution reaction [10]. Graphene oxide (GO) is a G-based material that has oxygen functional groups, which can serve as "anchors" to the metal particles to help the stability of HER [11–13]. Reduced graphene oxide (rGO) is also a G-based material that can be thermally, chemically, or electrochemically reduced from GO [14–19]. The number of functional groups in rGO is lower than in GO, which renders its higher conductivity, resulting in better HER performance [20,21]. Thus, these two materials have already been studied extensively with a variety of spectroscopic and optical methods [22–24].

The oxygen functional groups present in GO and rGO also have effects on the HER activity of cobalt catalyst (Co_xO_y) and should be studied for its specific role thoroughly. GO has several oxygen functional groups, i.e., carboxyl (-COOH), carbonyl (C=O), hydroxyl (-OH), and epoxide groups (C-O-C). Carboxyl and carbonyl groups reside on the edges of the GO sheet while hydroxyl and epoxide groups are attached to the carbon hexagonal grid [25]. These functional groups are important because they can interact with the cobalt ions, which increases the catalytic activity for the HER. The oxygen functional groups of GO and rGO can be identified using such as fourier-transform infrared spectroscopy, raman spectroscopy, and X-ray photoelectron spectroscopy, but to acquire additional information about the spatial distribution of these functional groups, scanning transmission X-ray microscopy (STXM) must be used

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